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AN ESTIMATE OF THE CONSUMPTION OF PETROLEUM ON THE EASTERN FRONT BY THE GERMAN ARMY AND AIR FORCE

(June 22-December 6, 1941)

~~Report No. 49~~

R&A 637

May 15, 1942

Copy No. 10 A
(6096)

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SUMMARY

1. Total petroleum consumption of the German ground and air forces on the Eastern Front, during the course of the June 22-December 6, 1941 campaign, amounted to about 2.4 million tons[1], an average of 430,000 tons a month.

2. Requirements of the ground forces accounted for approximately 70 percent of total consumption; some 1.7 million tons over the course of the campaign, or approximately 300,000 tons a month.

3. About 70 percent of these amounts were consumed in combat, about 30 percent by supply vehicles.

4. Average daily consumption ranged from a high of more than 11,000 tons per front (on the Central Front between June 22 and July 17) to a low of less than 800 tons per front (on the Northern Front between October 21 and November 1.)

5. For all divisions on the Eastern Front, average daily consumption per division works out to about 60 tons.

6. For divisions actively engaged in combat, average daily consumption was 90 tons. These divisions accounted for more than 90 percent of total ground force consumption.

7. The air force used about 700,000 tons of petroleum during the campaign, 30 percent of total consumption. Almost all of it was for flying planes rather than for supply service.

8. Germany's total consumption of petroleum during the second half of 1941 was running at the rate of about 1.3 million tons a month. In addition to the 430,000 tons a month on the Eastern Front, it is estimated elsewhere that other military consumption amounted to about 225,000 tons a month and that civilian consumption was 670,000 tons.

9. Production during this period was also running at a rate very close to 1.3 million tons a month.

10. Thus petroleum production and consumption were in approximate balance during the period of the war when Germany's military requirements were at their peak. At most she was compelled to make no more than negligible withdrawals from stocks.

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[1] All tonnage figures refer to metric tons.

AN ESTIMATE OF THE CONSUMPTION OF PETROLEUM
ON THE EASTERN FRONT BY THE GERMAN ARMY
AND AIR FORCE

(June 22-December 6, 1941)

I. INTRODUCTION

Detailed estimates of German petroleum consumption on the Russian Front during the June 22-December 6, 1941, campaign are presented in this report. Data on German consumption elsewhere than on the Russian Front and on production are also cited to indicate the effect of the campaign on Germany's general petroleum position.

There are many gaps in our knowledge of the Russian campaign. In estimating petroleum consumption of both the army and the air force, it is necessary at many points to resort to reasoned guessing. Thus there is a considerable margin of error in the findings of the study.

The estimating processes, however, are described in considerable detail, in the belief that they will be of interest and provide a methodology for estimating Germany's consumption of petroleum in subsequent campaigns. The numerous tables which summarize steps in the calculations are also included. For convenience of reference, all but the very brief unnumbered tables are grouped together at the back of the report.

II. THE ARMY'S CONSUMPTION OF PETROLEUM

In estimating petroleum consumption of the ground forces, combat and supply requirements must be considered separately. There are, however, certain factors which affect both consumption in combat and consumption for supply. These common factors are (1) vehicular composition; that is, the number of vehicles of each kind in each of the principal types of German army divisions; (2) the allocation of the vehicles as between combat use and supply service; and (3) the unit consumption of the vehicles; that is, the amount of fuel required to move all of a division's vehicles of a particular type one mile.

To estimate consumption of petroleum in combat it is necessary to know, in addition, (1) the average number of miles each type of vehicle is used per day under various kinds of combat conditions; and (2) the number of divisions of each type engaged under each kind of combat conditions.

To estimate consumption of petroleum for supply service it is necessary to know not only the unit consumption of the vehicle used for supply but also (1) the tonnages which were required to maintain the German armies; (2) the distances supplies had to be hauled; and (3) the capacity of the trucks used in various stages of the haul.

In estimating types of vehicles, their allocation to combat or service of supply and unit fuel consumption, only the three principal types of divisions--infantry, motorized, and panzer--were considered, since too few divisions of other types were engaged in the Russian campaign during the period under consideration to affect the computations seriously.

A. Factors of Consumption Common to Both Combat and Supply

1. Vehicular Composition. Estimates of the number of vehicles of each kind in each of the principal types of German army divisions are shown in Table 1. In making these estimates, General Headquarters troops and their equipment, including vehicles, were allocated to the infantry divisions, although there is, of course, no basis in fact for the assumption that they were assigned to infantry divisions exclusively.

2. Allocations of Vehicles for Combat and Supply. On the basis of the scanty evidence available and what little is known about the transportation needs of the German army, it was estimated that 30 percent of all light and medium trucks in the three types of divisions were used for supply.

3. Unit Fuel Consumption. Fuel consumption of German vehicles was assumed to be 20 percent lower than that of their American equivalents because of the lower horsepower of their engines.

Table 1 summarizes the estimates of the consumption of petroleum by divisional and GHQ vehicles. It shows the vehicular composition of each type of division; fuel consumption per vehicle; fuel consumption per mile for all the vehicles of a given kind in each type of division; and, finally, petroleum consumption per mile, which includes in addition to fuel consumption, 5 percent allowance for lubricants and greases.

B. Petroleum Consumption in Combat

The tonnage of petroleum used by the German army during the whole campaign was determined by estimating (1) for each type of vehicle in the three types of divisions the daily mileage in each type of combat and the resulting daily petroleum requirements per division, and (2) how many divisions were engaged for how many days in each type of combat.

1. Daily Mileage in Various Types of Combat. Data on petroleum consumption per mile for each kind of vehicle in each type of division has already been given in Table 1. The additional necessary data on the mileage covered by these vehicles in each type of combat will be given in Table 2. To obtain these data it was necessary (a) to ascertain the relative mileage of each kind of vehicle irrespective of combat or division, and (b) to compute factors that would take into account the intensity of combat, movement of front, and type of division.

a. Figures for Relative Mileage. To determine the relative mileage of different types of vehicles in the field, the Staff Officer's Field Manual 1/ was consulted. Figures given there were assumed to hold for the campaign as a whole. Thus automobiles and motorcycles were always assumed to travel 7.5 times as far as medium tractors; light and medium trucks, 5 times as far; medium armored cars, 4 times as far; heavy trucks and heavy armored cars, 3 times as far; and tanks and heavy tractors, 1.2 times as far.

1/ Paragraph 88, p. 9.

b. Computation of Factors. While different types of vehicles received the same relative amount of use through-out the campaign, the actual mileage varied in accordance with the intensity of combat, the movement of the front, and the kind of division to which the vehicles were attached. Factors which take these variables into account were estimated on the basis of the scheme worked out in The German Supply Problem on the Eastern Front (June 22-December 6, 1941).1/ The following seven types of action were distinguished.

(1) Major Push. This type of action is characterized by the familiar advance movement of the German motorized and panzer units, with the infantry operating in the rear. Often the daily advance during a Major Push is in the neighborhood of 75 miles, and the maximum expenditure of petroleum is therefore allocated to this type of action. During both a Major Push and Heavy Fighting (see below) panzer and motorized vehicles are believed to travel a third again as far as the corresponding infantry vehicles.

(2) Heavy Fighting. This is the type of engagement in which the infantry attempts to attain and consolidate the advance positions held by the motorized and panzer divisions. All units engaged are more or less directly in contact with the enemy, and considerable vehicular activity is characteristic.

(3) Slow Advance. In this form of action infantry divisions bear the brunt of attack against a not-too-active enemy.

(4) Defense. Defense involves a slight withdrawal and regrouping of forces. Again, only infantry divisions are assumed to be involved. During both Defense and Slow Advance petroleum consumption is believed to be moderate.

(5) Mopping-up (and Reconnaissance). Mopping-up is the type of fighting in which the army cleans out small groups of the enemy who have been left behind in a retreat. All kinds of divisions are utilized for Mopping-up operations. Petroleum consumption is believed to be considerable higher than in Slow Advance or in Defense, but not as great as in a Major Push. It has been assumed that the same amount of petroleum is consumed during Reconnaissance as during Mopping-up operations.

(6) Siege. This form of action, principally concentrated in the Leningrad area, primarily involves long-range artillery activity. Only infantry divisions are assumed to be involved, and it is believed that relatively little use is made of combat vehicles.

1/ Monograph No. 6, Coordinator of Information, March 25, 1942. See Chapter I.

(7) Inaction. This term refers to the activity of a division temporarily withdrawn from the fighting front. Obviously there is, strictly speaking, no combat utilization of petroleum during a period of Inaction, but a nominal allowance must be made for petroleum required for maneuvers.

After distinguishing these types of actions, it was next necessary to select factors for reducing all of the above descriptions to quantitative terms. The selection of these factors was to some extent arbitrary and even "circular." Factors were picked which, when multiplied by the figures for relative mileage, (see a., page 3) gave distances that appeared to be reasonable for the amount of traveling done by different types of vehicles under varying combat conditions. Where possible these computed distances were checked with independent information and it happens that the factor for Slow Advance and Defense, when so multiplied, gives distances the same as those shown for average travel per day in The Staff Officer's Field Manual (Par. 88).

As will be noted, different factors have been worked out for infantry and GHQ vehicles on the one hand and motorized and panzer vehicles on the other.

Vehicle Distance Factors

Type of Fighting	Infantry and GHQ Vehicles	Motorized and Panzer Vehicles
Major Push	13.32	20
Heavy Fighting	16.65	25
Slow Advance and Defense	10	--
Mopping-up (and Reconnaissance)	15	15
Siege	3.2	--
Inaction	2.5	2.5

Table 2 gives the results obtained when these factors are multiplied by the figures (see p. 4) for relative mileage of different types of vehicles in the field. It shows the average daily mileage of tactical vehicles by division and by type of combat.

Daily divisional petroleum requirements for any type of combat were estimated by multiplying divisional fuel requirements per mile (from Table 1) by the corresponding daily mileage figures in Table 2. For light and medium trucks, only 70 percent of the petroleum consumed was considered, since, as has been noted, 30 percent of these trucks are used for supply functions. The table below gives the result of these calculations. It shows daily divisional petroleum requirements for each of the seven types of activity which have been distinguished and described.

Daily Divisional Petroleum Consumption in Combat

(in tons)

Type of Combat	Infantry and GHQ	Motorized	Panzer
Major Push	74.51	91.85	119.69
Heavy Fighting	49.86	47.38	95.75
Slow Advance and Defense	38.48	--	--
Mopping-up (and Reconnaissance)	58.07	55	71.7
Siege	13.05	--	--
Inaction	9.67	9.19	11.97

2. The Number of Divisions Engaged in Each Type of Combat. The table above gives all the constants for computing estimated combat petroleum consumption for the whole campaign on the Eastern Front, June 22-December 6, 1941. To complete the computation it was necessary to know, in addition, how many divisions of each type were engaged in each type of activity, and the number of days they were so engaged. This information had to be secured through a careful military analysis of the entire Russian campaign. Such an analysis has been made, and is discussed in detail in Chapter I of The German Supply Problem on the Eastern Front (June 22-December 6, 1941), already cited.

The entire theater of operations was divided into three separate fronts, Northern, Central, and Southern, to correspond to a division recognized by the Germans themselves through the establishment, shortly after the initial generalized drive across the frontier, of three separate commands. Similarly, since the fighting varied in intensity and character throughout the 167-day campaign, to facilitate analysis it was divided into eight separate periods.

Table 3 summarizes the essential military facts about the campaign needed for a computation of combat requirements of petroleum. The table shows the number of divisions of each type engaged on each front during each period; the number engaged in each type of fighting; and the number of days they were so engaged.

By using the data in Table 3 and the estimates of daily divisional petroleum consumption in combat (from the table above), total combat requirements were computed by front, by period, and for the campaign as a whole. The results of these computations are given in Table 5.

C. Petroleum Consumption for Supply Service

To estimate the amount of petroleum consumed for service of supply it was necessary to have a general picture of Germany's supply system on the Eastern Front. That system has been carefully studied in a previous COI publication.1/ In general, railroads are the principal carriers for the major distance from the Zone of the Interior to the front. From the railheads, however, supplies are carried by motor truck to distribution points (dp), of which there tends to be one for each combat division, where they are further broken down for distribution to the men in the field. From the dp to the front, supplies are also carried mainly by truck.

The computation of the amount of petroldum consumed for supply service thus breaks down into two steps: (1) the amount required for hauling supplies from the railroads to the dp, and (2) the amount required for hauling supplies from the dp to the front. For both computations, however, the same basic information was needed, namely, the tonnages of supplies which had to be hauled, the distances they had to be hauled, the capacity of the vehicles used for hauling and, finally, their fuel capacity. This last factor has already been dealt with (see section on "Unit Fuel Consumption", page 3, and Table 1). The other three factors are discussed below.

1. Tonnages of Supplies To Be Transported. The tonnages of materiel required by the ground forces, like the amount of petroleum consumed in combat, vary in accordance with the severity of the fighting and, of course, in accordance with the number of divisions of each type engaged. In Chapter II of the monograph, The German Supply Problem, the amounts of materiel needed daily for various types of activity were carefully estimated, though the main emphasis there was on tonnages which had to be laid down at the railheads. It is not these tonnages but the amounts which had to be moved from the railheads to the dp, and from the dp to the front, that are important in estimating petroleum consumption of supply service.

By no means all of the materiel required at the railheads had to be transported to the dp. Ordnance, one of the largest categories of materiel, is largely composed of vehicles capable of making the trip from railheads to the front under their own power, and hence enter the picture only in terms of their own petroleum consumption and not as deadweight tonnage. It is estimated that half of the materiel needed by GHQ troops remains back at the railheads.

1/ The German Supply Problem on the Eastern Front (June 22-December 6, 1941), see in particular Sections 2, 3, and 4 of the Summary and Chapter III.

Still further reduction occurs on the way to the dp because inactive divisions, it has been assumed, are stationed halfway between the railheads and the dp.[1]

The reduction in the amount of materiel to be transported from railheads to the dp ranges, according to type of division and kind of activity, from a high of 26 percent (for infantry divisions engaged in Mopping-up operations) to a low of 7 percent (for panzer divisions engaged in a Major Push). Estimates of tonnages which had to be hauled daily from the railheads to the dp are given in the table below.

Tonnages of Materiel Hauled Daily from Railheads
to Distribution Points

Type of combat	Infantry and GHQ	Motorized	Panzer
Major Push	572	715	741
Heavy Fighting	1118	671	717
Slow Advance	709	---	---
Defense	512	---	---
Mopping-up (and Reconnaissance)	333	197	151
Siege	454	---	---
Inaction	82	30	29

The quantities of materiel which have to be hauled from the dp to the front vary somewhat from the quantities which have to be hauled from the railheads to the dp. At or near the dp, flour, yeast, and salt are made into bread, and livestock is converted into dressed meat. The net effect of these operations is a gain in the weight of food to be transported. On the other hand, supplies of clothing and some guns are left at the dp, and in the case of infantry divisions the reduction in the amount of ordnance to be transported to the front more than counter-balances the increase in the weight of food to be transported. Thus the tonnages of supplies which are hauled from the dp to the front are less in the case of infantry divisions and greater in the case of panzer and motorized divisions than tonnages hauled from railheads to the dp. The figures, by division and type of activity, are given in the table below.

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[1] Because the tonnages of supplies needed by inactive divisions are so much less than those needed by active divisions, even a considerable margin of error with regard to this assumption would not seriously affect the estimate of total petroleum consumption.

Tonnages of Materiel Hauled Daily from Distribution Points to the Front

Type of combat	Infantry and GHQ	Motorized	Panzer
Major Push	571	718	743
Heavy Fighting	1117	673	719
Slow Advance	708	---	---
Defense	511	---	---
Mopping-up (and Reconnaissance)	332	199	153
Siege	453	---	---

2. Distances Supplies Had To Be Transported. The distances supplies had to be hauled from railheads to the dp varied on the three fronts during the different stages of the campaign. In the first period (June 22-July 17) it is believed that no railheads had been established, and as a consequence supplies had to be hauled by truck sometimes as far as 300 miles. The average distances supplies had to be hauled by truck on each front during each period, in order to be laid down at the dp, are shown in Table 4.

The distance that supplies had to be hauled from the dp to the front was also estimated. For want of more precise information, it has been assumed that infantry divisions operated, on the average, 10 miles in advance of the dp and panzer and motorized divisions 30 miles in advance.

3. Capacity of the Vehicles Used for Hauling. After tonnages and distances had been estimated, the capacity of the trucks utilized for hauling had to be worked out before fuel requirements could be computed. For the purposes of this analysis it was more or less arbitrarily assumed that the hauling of supplies between railheads and the dp was handled by 30 percent of the medium (2-ton capacity) trucks attached to each type of division. Smaller trucks would have been inefficient in view of the tonnages to be carried, the distances involved, and the larger fuel consumption of the light trucks per ton mile. Larger trucks may often have been employed; it is known that heavy GHQ trucks were thrown into the breach whenever demands on the trucks attached to field divisions became excessive. However, the increased fuel consumption of these trucks about counter-balances their greater carrying capacity, so that from the standpoint of petroleum utilization it makes little difference whether they or medium trucks were used.

For transporting supplies for the relatively short distances between the dp and the front it was assumed that 30 percent of all light (1-ton capacity) trucks were employed.

4. Method of Computation. Once all the foregoing information had been brought together, the actual computation of the amount of petroleum required for supply service was relatively simple. The amount of fuel required for hauling supplies from the railheads to the dp was first estimated as follows:

(a) The total tonnages of supplies to be transported were determined by multiplying the figures in the table on page 8 by the figures from Table 3, which showed the number of divisions of each type engaged in various types of activity and the number of days they were so engaged.

(b) These tonnage requirements were translated into supply-truck miles. This meant dividing total requirements by two (since 2-ton trucks were employed) and multiplying this figure by the round-trip distance supplies had to be hauled (the figures in Table 4 multiplied by 2). Since the division of requirements by 2 and the multiplication of distance by 2 canceled one another out, the actual process followed was simply to multiply total requirements by the figures in Table 4.

(c) The petroleum the supply vehicles required was then computed by multiplying the final truck-mile figure by the unit petroleum consumption of the trucks used for the haul (from Table 1, thirty percent of the unit petroleum consumption shown for medium trucks.)

An exactly analogous process was, of course, followed in computing the petroleum needed for hauling supplies from the dp to the front.

(a) The tonnages to be transported were estimated by multiplying the figures in the table on page 8 by the appropriate figures from Table 3.

(b) These figures were then translated into supply-truck miles. Since infantry divisions were assumed to operate 10 miles in advance of the dp, their tonnage requirements were multiplied by 20 (to allow for the round trip). Since panzer and motorized divisions operate 30 miles in advance, their requirements were multiplied by 60.

(c) Petroleum consumption was then computed by multiplying the two figures obtained in the above step by the unit petroleum consumption of the 1-ton trucks used in this stage of the haul (30 percent of all 1-ton trucks).

In computing the total amount of petroleum used for supply it was necessary not only to add the amounts used for transporting materiel between the railheads and the dp and the dp and the front, but also to make allowance for two additional relatively unimportant factors. The first of these was the petroleum consumed by ordnance vehicles which, it will be remembered, are assumed to move up from the railheads under their own power. The monograph, The German Supply Problem, gives an estimate of the proportion of vehicles of each type replaced monthly in each of the three principle types of divisions, under both active and inactive conditions.[1] On the basis of these data, the number of vehicles brought up on each front during each period was estimated. The unit petroleum consumption of these vehicles was computed from Table 1, and this figure multiplied by the distances from the railheads to the dp on the various fronts during the different periods (Table 4).

Finally, allowance had to be made for the petroleum needed for the supply vehicles themselves. This petroleum was treated like any type of materiel. It was assumed that it was hauled only as far as the dp, and that 2-ton trucks were used in the operation.

Table 5 shows the tonnages of petroleum required for supply purposes by front and by period and for the campaign as a whole.

D. Recapitulation

Through the processes described, the German army's petroleum consumption for both combat purposes and supply service has been estimated, by front and by period, for the June 22-December 6, 1941 campaign on the Eastern Front. Table 5 presents these estimates in summary form. Over the five-and-a-half-month campaign, it will be seen, the ground forces consumed some 1.7 million tons of petroleum.

Almost 1.2 million tons--approximately 70 percent of the total amount--was consumed in combat. About 525,000 tons--approximately 30 percent of the total amount--was consumed in bringing supplies forward.

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[1] The German Supply Problem on the Eastern Front (June 22-Dec. 6, 1941), see pp. 69-70 and Tables 22 a-d, pp. 156-159.

Another interesting point which emerges is that more than 90 percent of the total was used by active divisions, although over the course of the campaign only 60 percent of the divisions, on the average, were engaged at any one time in active combat. Inactive divisions, although they constituted 40 percent of all divisions, used less than 10 percent of the total amount of petroleum required for the campaign.

Estimates of theoretical maximum petroleum expenditure are shown in Table 6. This is the expenditure that would have resulted if all divisions had been not only active but engaged in the type of combat involving maximum petroleum consumption--a Major Push--and if the transportation of supplies had also been maintained at a maximum. Theoretical maximum petroleum expenditure on this basis is estimated at some 3.3 million tons for the campaign, almost twice actual expenditure.

Consumption figures are shown on a daily average basis in Tables 7 and 8. Table 7 shows the total daily tonnages of petroleum consumed by the German ground forces on each front during each period. It will be noted that consumption ranged from a high of more than 11,000 daily per front (Central Front, between June 22 and July 17, a period when 90 divisions were engaged) to a low of less than 800 tons daily (Northern Front, between October 21 and November 1, a period when 35 divisions were engaged). Table 8 shows the tonnages of petroleum consumed daily per division on each front during each period. Consumption per division varied from a high of approximately 125 tons daily (Central Front, June 22-July 17) to a low of little more than 20 tons daily (Northern Front, October 21-November 1). The average number of divisions engaged on all fronts in the entire campaign was 175, and the average daily consumption of petroleum per division was roughly 60 tons. The average daily consumption per active division--and this is perhaps a more significant figure--was approximately 90 tons.

It is possible to go one step further and estimate average daily petroleum consumption per vehicle. Lumping infantry, panzer, and motorized divisions together, it may be said that the average German division has some 3500 vehicles. Each vehicle consumed, on the average, 6 gallons of petroleum daily over the course of the campaign. The daily consumption of vehicles attached to active divisions, however, was 9 gallons, and vehicles operating under conditions requiring maximum petroleum expenditures consumed more than 11 gallons daily. Inactive divisions, on the other hand, consumed only a gallon a day per vehicle.

III. THE AIR FORCE'S CONSUMPTION OF PETROLEUM

In estimating the air force's consumption of petroleum on the Eastern Front during the June 22-December 6, 1941 campaign, three basic factors had to be considered: (1) the number of planes involved; (2) the estimated consumption per plane; and (3) the consumption of fuel used at the airdromes and in carrying supplies to the airdromes.

It is believed that the number of German air fleets on the Russian Front varied at different stages of the campaign as shown in the table below.

Disposition of Air Fleets

Front	June 22-Sept.25	Sept. 26-Nov.1	Nov. 2-Dec.6
Northern	1	-	-
Central	3	3	2
Southern	1	1	1

Though there is no fixed number of planes in a German air fleet, estimated allocations range upward of 600 planes (Handbook on German Military Forces TM 30-450, p. 329). On the basis of information from both the Army air corps and British sources, estimates have been made of the number of planes of each type on each section of the front during each period of the campaign. These estimates are summarized in Table 9. An attempt has been made not only to break down the number of planes into types (single-engine fighter, dive bomber, etc.) but also to indicate the number of planes of each type used in combat and as trainers. In general, estimates of the total number of planes are those of Army Air Intelligence, and estimates of the number of planes used in combat have been largely derived from the British Air Ministry. The difference between these two estimates has been taken as the number of planes used for training.1/

1/ According to the most recent information, the total number of planes on the Eastern Front was somewhat lower than was assumed when Table 9 was prepared; and the proportion of planes used in combat was somewhat higher (if both initial equipment and initial reserves are considered) than the breakdown there given suggests. These differences tend to offset one another, and it is believed that they do not significantly affect the estimate of petroleum consumption.

In estimating petroleum consumption of the planes, the basic source was logistic data of the United States Army Air Corps contained in a table prepared by the Statistics Section of A-4 on January 1, 1942, entitled "Thirty Days Supply per Operating Tactical Airplane." Table 10 shows the process followed in estimating daily petroleum requirements of each model of German plane in common use on the Russian Front. A-4 established comparisons between the various models of German planes and American models, whose fuel capacity and total petroleum consumption is known, and worked out conversion factors for differences between corresponding models. It was assumed that both German and American planes consume approximately three-quarters of a tank of gas per flight. From this the fuel consumed per flight by each model of German plane was computed. Finally, largely on the basis of information furnished by A-4, the average number of flights each type of plane takes per month was estimated, and one-thirtieth of this figure was used as a multiplier in estimating daily consumption.

Information in Table 10 and estimates in Table 9 of the number of planes operating in each period on each front made possible the estimate of total daily petroleum consumption by German planes on each of the three fronts for each period of the campaign. The results are shown in Table 11.

In arriving at a figure for total consumption of petroleum by the German air force, the amount used at airdromes and in carrying supplies to airdromes also had to be taken into account. The quantity of supplies required by the air force--considering bombs and ordnance carried by the planes, their fuel requirements, and food and clothing needs of air-force personnel--was estimated in Chapter II of the monograph, The German Supply Problem. Total requirements work out to roughly one ton per plane per day. It was assumed that most of these supplies were brought to the air fields from the railheads by truck. In computing the petroleum required for this service, all airplanes were considered to be based at a point one-quarter of the average distance from the railheads to the front during a given period. This rough estimate averaged out the following three factors:

(1) that dive bombers and some of the short-range pursuit planes were fairly close to the front;

(2) that heavier bombers and some of the pursuit planes were probably close to the railheads; and

(3) that some fuel was required for transport at the airdromes themselves.

Table 12 shows, by period and by front, the tonnages of material needed daily by the air force, the average distances to the airports, and the amounts of petroleum consumed daily for transporting supplies. These amounts constitute only a small percentage of the air force's total daily petroleum requirements. Even if all supplies for the air force had had to be hauled the entire distance from the railheads to the dp, the petroleum required for the carriers would have come to less than 5 percent of the air force's total petroleum requirements.

Table 13 shows the total amount of petroleum--some 700,000 tons--estimated to have been consumed by the German air force, including both that needed by the planes themselves and that used in their supply. Table 14 reduces this information to a per diem basis.

Air-force consumption came to roughly 30 percent of total petroleum requirements. Practically all of the fuel and lubes consumed by the air force was used for flying planes; only negligible amounts were needed for service of supply.

IV. GERMANY'S GENERAL PETROLEUM SITUATION

Total petroleum consumption by the German forces on the Eastern front amounted to about 2.4 million tons, the sum of the estimated requirements of the army and the air force. Table 15 shows this total consumption by front and by period and for the campaign as a whole. Table 16 gives the same information on a per diem basis. Over the course of the entire June 22-December 6, 1941, campaign, the Germans consumed petroleum at an average rate of more than 14,000 tons per day or 430,000 tons per month.

These figures become more meaningful if they are seen in the light of what is known about Germany's general petroleum position. What were her total military requirements of petroleum during this period? What was the rate of civilian consumption? Finally, what was Germany's oil production at the time of the campaign on the Russian Front?

These questions must be answered on the basis of very rough calculations. Nevertheless it is worthwhile to attempt to see how straitened Germany's petroleum situation was during that period of the war when consumption was at its peak.

Germany's military consumption of petroleum elsewhere than in the Russian theater is believed to have been running at the rate of some 225,000 tons per month during this period. This estimate, an admittedly crude approximation, was derived as follows:

(1) It was assumed that there were some 125 divisions stationed in Germany, occupied Europe, etc., and that they averaged some 12 tons of petroleum per day, a total of about 45,000 tons per month.

(2) It was assumed that Germany had, on the average, some 3500 planes (including both trainer and combat planes) elsewhere than on the Russian Front in the last half of 1941. The petroleum consumption of these planes was estimated to be roughly half that of planes on the Eastern Front; i.e., approximately 0.375 ton per plane per day, or some 40,000 tons per month.

(3) Todt organizations were estimated to have consumed some 40,000 tons of fuel per month during this period (estimate given in the report of the Hartley Committee).

(4) German and Italian naval consumption was estimated to have been running at a rate of approximately 100,000 tons per month (Hartley Committee estimate).

The above estimates and the estimate arrived at in this report suggest that Germany's total military consumption of petroleum during the last half of 1941 was approximately 650,000 tons per month.

While there is no agreement on the rate of civilian consumption of petroleum in Axis-Europe during this period, a reasonable estimate indicates that it was proceeding at the rate of some 670,000 tons per month.1/ Thus total consumption is believed to have been in the neighborhood of 1.3 million tons per month.

Estimates of German oil production for the last half of 1941 also vary, but most estimates indicate that production was proceeding at an annual rate of approximately 15.5 million tons, or a monthly rate of almost 1.3 million tons.

Admittedly, all of the above estimates are subject to a considerable margin of error, but they are based upon the best information now available. It may be concluded that during the period of her greatest sustained offensive to date, Germany was compelled to make no more than negligible withdrawals from the stocks she had accumulated before the war and in the early stages of the struggle. At any time during this period she probably could have achieved a balance between consumption and production by imposing additional restrictions on on the nonmilitary use of petroleum.

Furthermore, she could meet her needs in all important categories of petroleum products. Despite the fact that roughly 95 percent of the petroleum consumed by the ground and air forces consisted of fuel, mostly gasoline, in view of the estimated production of German synthetic oil plants and the estimated yield from the crudes available to her, it appears that Germany was able to produce enough gasoline to meet both her military and essential civilian requirements. It also appears that she had ample lubes and greases for her needs.

1/ Broken down as follows:

	Tons per month
Germany	290,000
Italy (including army)	175,000
Rumania	85,000
Occupied Europe	120,000
Total	670,000

APPENDIX A. A NOTE ON THE CONSUMPTION OF PETROLEUM BY THE GERMAN FORCES ON THE EASTERN FRONT DURING THE WINTER MONTHS

Germany's consumption of petroleum from December 7, 1941, to March 31, 1942, has not been carefully studied. However, some worthwhile conclusions may be drawn by putting together the estimates made in this report of consumption during the final phases of the June 22-December 6, 1941, campaign, and what is known about the disposition of German forces during the winter.

(1) During the period, November 18-December 6, 1941, the petroleum consumption of the army and air force mounted to some 210,000 tons--approximately 11,000 tons per day. The consumption of the ground forces alone was 150,000 tons--approximately 50 tons per day for each of the 160 divisions on the front during this period. Airforce consumption was some 60,000 tons. The air force consumed more than 3000 tons a day--almost 20 tons for each division on the front during this period.

(2) It is estimated that during the winter the Germans had 85 divisions of all types on the front.

(3) During the winter, fuel was undoubtedly consumed at a considerably lower rate than it was between November 18 and December 6, a period which covered the Moscow offensive. It may be assumed that average daily petroleum requirements were those of Defense--in the neighborhood of 40 tons per day per division. Even if the consumption of the air force continued at the rate of 20 tons per day for each division on the front, total consumption of petroleum during the winter months amounted only to some 60 tons per division. On this basis it is estimated that monthly consumption for the period, December 7, 1941-March 31, 1942, was approximately 150,000 tons.

(4) This estimate, too, must be seen in relation to Germany's general petroleum position for its significance to be appreciated. Even if 50,000 tons per month is added to the previous estimate of Germany's military consumption of petroleum elsewhere than on the Russian Front, in order to allow for consumption by divisions transferred from that front after December 6, total military consumption of petroleum would have amounted to no more than 420,000 tons per month during the winter. If civilian consumption continued at the rate of 670,000 tons per month, total consumption during the winter was approximately 1.1 million tons per month. German production, it will be remembered, was estimated at some 1.3 million tons per month during the time of the June 22-December 6, 1941, campaign.

(5) The conclusion is inescapable that the Germans were able to make considerable accretions to stock during the winter. Previous estimates of Germany's stock position must be modified accordingly. Largely on the basis of the Hartley report it was estimated in The German Oil Position 1/ that Germany's military consumption of petroleum during the winter would be 850,000 tons a month, and that by April 1, 1942, her stocks would be reduced to some 2.7 million tons. If, instead, military consumption was only 420,000 tons a month, as estimated here, Germany would have had on April 1 some 1.6 million more tons of petroleum than previously estimated, or approximately 4.3 million tons. Instead of having been reduced, her stocks would have been increased by some 800,000 tons.

1/ COI Economics Division Report No. 13, "The German Oil Position", February 24, 1942.

TABLE 1. CONSUMPTION OF PETROLEUM BY DIVISIONAL AND GHQ VEHICLES

Type of Vehicle	Number of Vehicles per Division			Fuel Consumption per Vehicle		Total Fuel Consumption per Mile						Total Petroleum Consumption per Mile 1/		
	Infantry and GHQ Vehicles	Motor-ized	Pan-zer			Infantry and GHQ Vehicles		Motorized		Panzer		Infantry and GHQ Vehicles	Motor-ized	Panzer
				Miles	Gal.	Gallons	Tons	Gallons	Tons	Gallons	Tons	Tons	Tons	Tons
Trucks:														
Light	607	224	1057	15		40.4	.127	14.9	.042	70.5	.197	.133	.044	.207
Medium	1632	1406	744	10		163.2	.527	140.6	.394	74.4	.208	.553	.414	.218
Heavy	122	58	105	6		20.3	.063	9.7	.027	17.5	.049	.066	.028	.051
Auto-mobiles:														
Medium	109	88	411	18		6.0	.018	4.9	.014	25.6	.072	.019	.015	.076
Heavy	46	--	16	15		--	--	---	--	--	--	--	--	--
Armored Cars:														
Medium	--	--	50	3		--	--	---	--	17	.048	--	--	.050
Heavy	3	25	27	2		1.5	.004	13	.036	14	.039	.004	.038	.041
Motor-cycles:	723	1400	1000	40		18.1	.061	35	.118	25	.085	.064	.124	.089
Tractors and Half-tractors:														
Medium	157	420	318	2		79	.223	210	.588	159	.445	.234	.617	.467
Heavy	40	30	---	1		40	.112	30	.084	---	--	.118	.088	--
Tanks:														
Light	--	--	280	2		--	--	--	--	140	.392	--	--	--
Medium	--	--	150	1		--	--	--	--	150	.420	--	--	.441
Total	3429	3651	4158	--		368.5	1.135	458.1	1.303	693.0	1.955	1.191	1.368	2.052

1/ An additional 5 percent has been added for lubes and grease.

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TABLE 2. AVERAGE DAILY MILEAGE OF TACTICAL VEHICLES IN VARIOUS TYPES OF ACTIVITY

		Major Push	Heavy Fighting	Slow Advance and Defense	Mopping-up (and Reconnaissance)	Siege	Inaction
			Infantry and GHQ Vehicles				
Automobiles		125	100	75	112.5	26.25	18.75
Motorcycles		125	100	75	112.5	26.25	18.75
Trucks:	Light & Medium	83.3	67	50	75	17.5	12.5
	Heavy	50	40	30	45	10.5	7.5
Armored Cars:	Light	66.7	53	40	60	10.5	7.5
Tractors and ½ tractors:	Medium	20	16	12	18	4.2	3.0
	Heavy	16.7	13.3	10	15	3.5	2.6
			Motorized and Panzer Division Vehicles				
Automobiles		187.5	150		112.5		18.75
Motorcycles		187.5	150		112.5		18.75
Trucks:	Light & Medium	125	100		75		12.5
	Heavy	75	60		45		7.5
Armored Cars:	Medium	100	80		60		10.
	Heavy	75	60		45		7.5
Tractors and ½ tractors:	Medium	30	24		15		3
	Heavy	26	20		12		2.6
Tanks:	Light	30	24		18		3.
	Medium	30	24		18		3.

TABLE 3. ACTIVITY OF GERMAN FORCES IN RUSSIAN CAMPAIGN

Periods

FRONT	June 22 to July 17 (26 days)			July 18 to August 1 (14 days)			August 2 to August 20 (19 days)			August 21 to September 25 (36 days)		
	No. and type of divisions	Type of activity	No. of days	No. and type of divisions	Type of activity	No. of days	No. and type of divisions	Type of activity	No. of days	No. and type of divisions	Type of activity	No. of days
	28 Inf	MP	10	20 Inf	HF	8	20 Inf	HF	6	25 Inf	MP	12
		MU	6		MU	6		Re	5		Re	4
N		HF	10	4 Mot	MU	6		SA	8		HF	20
O	3 Panz	MP	10				3 Panz	MP	4	3 Panz	HF	12
R	4 Mot	MP	10				4 Mot	MP	4	4 Mot	HF	12
T		MU	5					Re	5		Re	6
H	10 Inf	In	26	13 Inf	In	14	13 Inf	In	19	8 Inf	In	36
	3 Panz	In	16	3 Panz	In	14	3 Panz	In	15	3 Panz	In	24
	4 Mot	In	11	4 Mot	In	8	4 Mot	In	10	4 Mot	In	18
	50 Inf	HF	8	40 Inf	HF	14	35 Inf	HF	10	20 Inf	DF	36
C		MP	12	9 Panz	MP	5		DF	9	4 Mot	Re	10
E		Re	6	10 Mot	MP	5	4 Mot	Re	10			
N	9 Panz	MP	12		Re	5						
T	10 Mot	MP	12									
R		Re	6									
A	21 Inf	In	26	26 Inf	In	14	31 Inf	In	19	13 Inf	In	36
L	9 Panz	In	14	9 Panz	In	9	9 Panz	In	19	3 Panz	In	36
	10 Mot	In	8	10 Mot	In	4	6 Mot	In	19	4 Mot	In	26
							4 Mot	In	9			
	30 Inf	HF	5	26 Inf	HF	9	31 Inf	HF	3	31 Inf	HF	15
		MP	15		Re	2		MP	12		MP	11
		Re	6		MP	3		Re	4		Re	
											MU	10
S	6 Panz	MP	15	6 Panz	MP	3	6 Panz	MP	12	25 Inf	DF	12
O	8 Mot	MP	15	8 Mot	MP	3	8 Mot	MP	12		MP	8
U		Re	4		Re	5		Re	7		HF	10
T											Re	
H											MU	6
										12 Panz	MP	14
										14 Mot	MP	14
											Re	
											MU	10
	16 Inf	In	26	15 Inf	In	14	10 Inf	In	19	18 Inf	In	36
	6 Panz	In	11	6 Panz	In	11	6 Panz	In	7	12 Panz	In	22
	8 Mot	In	7	8 Mot	In	6				14 Mot	In	12

Note: For definition of type of activity see pp. 4 and 5.
Abbreviations used in table are as follows:

HF = Heavy Fighting
MP = Major Push
SA = Slow Advance
DF = Defensive Fighting
MU = Mop-up
Re = Reconnaissance
In = Inactive
Si = Siege
Inf = Infantry
Panz = Panzer
Mot = Motorized

(continued on next page)

TABLE 3. ACTIVITY OF GERMAN FORCES IN RUSSIAN CAMPAIGN (Cont.)

	Periods											
	September 26 to October 20 (25 days)			October 21 to November 1 (12 days)			November 2 to November 17 (16 days)			November 18 to December 6 (19 days)		
	No. and type of divisions	Type of activity	No. of days	No. and type of divisions	Type of activity	No. of days	No. and type of divisions	Type of activity	No. of days	No. and type of divisions	Type of activity	No. of days
	12 Inf	MU	12	10 Inf	Si	12	10 Inf	Si	16	10 Inf	Si	19
		Si	13	10 Inf	DF	12	10 Inf	HF	3	10 Inf	HF	10
N	8 Inf	DF	3	4 Mot	Re	4		MP	7		DF	9
O		SA	15					Re	6	4 Mot	Re	12
R		MP	7				4 Mot	MP	7			
T	4 Mot	MP	5					Re	4			
H		Re	4									
	11 Inf	In	25	11 Inf	In	12	11 Inf	In	16	11 Inf	In	19
	4 Mot	In	16	4 Mot	In	8	4 Mot	In	5	4 Mot	In	7
	20 Inf	DF	6	40 Inf	SA	12	40 Inf	SA	16	40 Inf	Re	4
C	50 Inf	Re	4	6 Mot	Re	6	6 Mot	Re	5		MP	8
E		MP	7								HF	7
N		HF	8							12 Panz	MP	8
T	12 Panz	MP	7							10 Mot	MP	8
R	10 Mot	MP	7								Re	4
A		Re	6									
L	43 Inf	In	6	18 Inf	In	12	18 Inf	In	16	18 Inf	In	19
	13 Inf	In	25	12 Panz	In	12	12 Panz	In	16	12 Panz	In	11
	12 Panz	In	18	4 Mot	In	12	4 Mot	In	16	10 Mot	In	7
	10 Mot	In	12	6 Mot	In	6	6 Mot	In	11			
	16 Inf	DF	6	15 Inf	SA	12	15 Inf	HF	10	15 Inf	HF	10
	25 Inf	MP	8	5 Inf	HF	10		SA	6		SA	9
		Re	5		Re	2	4 Mot	Re	6	5 Inf	MP	4
		SA	6	4 Mot	Re	6		MP	6		HF	7
S	6 Panz	MP	8				1 Panz	MP	6		DF	8
O	8 Mot	MP	8				5 Inf	MP	6	6 Panz	MP	5
U		Re	5					HF	10	8 Mot	MP	5
T											Re	4
H	20 Inf	In	6	11 Inf	In	12	11 Inf	In	16	11 Inf	In	19
	11 Inf	In	19	6 Panz	In	12	4 Mot	In	4	6 Panz	In	14
	6 Panz	In	17	4 Mot	In	6	4 Mot	In	16	8 Mot	In	10
	8 Mot	In	12	4 Mot	In	12	1 Panz	In	10			
							5 Panz	In	16			

Note: Abbreviations used of this page are the same as those used on the preceding page.

TABLE 4. AVERAGE DISTANCES SUPPLIES OF GROUND FORCES HAD TO BE HAULED BY TRUCK, FROM RAILHEADS TO DISTRIBUTION POINTS

Front	June 22-July 17	July 18-Aug. 1	Aug. 2-Aug. 20	Aug. 21-Sept. 25	Sept. 26-Oct. 19	Oct. 20-Nov. 1	Nov. 2-Nov. 17	Nov. 18-Dec. 6
Northern	110	60	75	45	10 1/ 35 2/	10 1/ 25 2/	10 1/ 45 2/	10 1/ 45 2/
Central	235	135	110	60	110	85	60	85
Southern	135	110	185	85	45	110	45	85

1/ Siege of Leningrad.

2/ Fighting aroung Rzhev, Vysokee, etc.

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TABLE 5. TOTAL PETROLEUM CONSUMPTION BY GERMAN GROUND FORCES

(in thousands of tons)

Front		Total June 22-Dec.6			June 22-July 17			July 18-Aug. 1			Aug. 1-Aug. 20			Aug. 21-Sept. 25		
		Combat	Supply	Total	Combat	Supply	Total	Combat	Supply	Total	Combat	Supply	Total	Combat	Supply	Total
Northern	Active	213.4	45.9	259.4	53.1	22.9	76.1	16.3	3.1	19.3	21.9	6.9	28.9	62.5	7.7	70.2
	Inact.	23.1	1.5	24.6	3.6	0.5	4.1	2.6	0.2	2.8	3.4	0.2	3.6	4.4	0.2	4.6
	Total	236.7	47.3	284.0	56.8	23.4	80.2	18.9	3.2	22.1	25.3	7.2	32.5	66.9	7.9	74.8
Central	Active	408.6	310.3	718.9	109.7	175.2	284.9	40.8	40.2	81.0	31.7	21.8	53.5	29.6	5.3	34.9
	Inact.	55.0	6.4	61.3	7.7	2.0	9.7	5.0	.9	5.9	9.3	.9	10.2	6.9	.4	7.3
	Total	463.5	316.6	780.2	117.4	177.2	294.6	45.7	41.1	86.9	41.0	22.7	63.6	36.5	5.7	42.2
Southern	Active	420.0	156.7	576.7	75.3	36.4	111.7	27.1	14.6	41.7	60.3	32.3	92.6	155.5	47.9	203.4
	Inact.	37.3	3.3	40.7	5.5	1.0	6.5	3.3	.3	3.6	2.4	.4	2.8	11.2	.8	12.0
	Total	457.4	159.9	617.3	80.7	37.4	118.1	30.5	14.9	45.3	62.7	32.7	95.4	166.6	48.7	215.4
All Fronts		1,157.4	524.2	1,681.4	254.9	238.0	493.0	95.1	59.3	154.3	128.9	62.6	191.5	270.0	62.4	332.3

TABLE 5. TOTAL PETROLEUM CONSUMPTION BY GERMAN GROUND FORCES (cont.)

Front		Sept. 26-Oct. 20			Oct. 21-Nov. 1			Nov. 2-Nov. 17			Nov. 18-Dec. 6		
		Combat	Supply	Total	Combat	Supply	Total	Combat	Supply	Total	Combat	Supply	Total
Northern	Active	23.3	1.3	24.6	7.0	0.6	7.6	15.8	1.5	17.3	13.5	1.9	15.4
	Inact.	3.3	0.1	3.4	1.6	.1	1.7	1.9	0.1	2.0	2.3	0.1	2.4
	Total	26.6	1.4	28.0	8.6	0.7	9.3	17.7	1.6	19.3	15.9	1.9	17.8
Central	Active	82.2	35.5	117.7	20.2	8.6	28.9	26.0	6.2	32.1	68.4	17.5	85.9
	Inact.	9.5	.9	10.4	4.6	.4	5.0	6.4	.4	6.7	5.6	.5	6.1
	Total	91.7	36.4	128.1	24.9	9.0	33.0	32.3	6.5	38.9	74.0	18.0	92.0
Southern	Active	45.4	4.7	50.1	11.2	7.6	18.8	18.8	3.1	21.9	26.4	10.1	36.5
	Inact.	5.4	.2	5.6	2.4	.2	2.6	3.3	.1	3.5	3.8	.3	4.1
	Total	50.8	4.9	55.7	13.6	7.8	21.4	22.2	3.2	25.4	30.3	10.3	40.6
All Fronts		169.1	42.7	211.8	47.1	17.5	64.6	72.2	11.4	83.5	120.1	30.3	150.4

TABLE 6. THEORETICAL MAXIMUM EXPENDITURE OF PETROLEUM BY THE GERMAN GROUND FORCES

(in tons)

Front	Total June 22-Dec. 6	June 22-July 17	July 18-Aug. 1	Aug. 2-Aug. 20	Aug. 21-Sept. 25	Sept. 26-Oct. 20	Oct. 21-Nov. 1	Nov. 2-Nov. 18	Nov. 18-Dec. 6
Northern	549,720	129,644	47,355	69,001	116,571	63,500	30,707	42,745	50,197
Central	1,596,537	549,973	156,947	178,015	122,611	240,773	95,746	114,041	138,431
Southern	1,116,441	202,531	87,190	146,359	362,953	108,783	60,834	61,789	86,002
All Fronts	3,262,698	882,148	291,492	393,375	602,135	413,056	187,287	218,575	274,630

TABLE 7. DAILY CONSUMPTION OF PETROLEUM BY THE GERMAN GROUND FORCES

(in tons)

Front	June 22-July 17	July 18-Aug. 1	Aug. 2-Aug. 20	Aug. 21-Sept. 25	Sept. 26-Oct. 20	Oct. 21-Nov. 1	Nov. 2-Nov. 17	Nov. 18-Dec. 6
Northern	3,085	1,581	1,658	2,077	1,118	771	1,207	938
Central	11,331	6,205	3,350	1,172	5,125	2,822	2,429	4,841
Southern	4,544	3,239	5,019	5,982	2,229	1,787	1,586	2,136
All Fronts	18,960	11,025	10,027	9,232	8,472	5,380	5,222	7,915

TABLE 8. DAILY CONSUMPTION OF PETROLEUM PER DIVISION

(in tons)

Front	June 22- July 17	July 18- Aug. 1	Aug. 2- Aug. 20	Aug. 21- Sept. 25	Sept. 26- Oct. 20	Oct. 21- Nov. 1	Nov. 2- Nov. 17	Nov. 18- Dec. 6
Northern	69	40	41	52	32	22	34	27
Central	126	73	39	29	60	35	30	61
Southern	76	59	91	60	45	40	35	47
All Fronts	271	172	171	141	137	97	99	135

TABLE 9. NUMBER OF GERMAN PLANES USED FOR COMBAT AND TRAINING.

Front	Type	June 22-Sept. 25				Sept. 26-Nov. 1				Nov. 2-Dec. 6			
				Total				Total				Total	
		Combat	Training	Number	Percent	Combat	Training	Total	Percent	Combat	Training	Total	Percent
Northern	Single-eng. Pursuit	130	70	200	20.1	----	----	----	----	----	----	----	----
	Twin-eng. Pursuit	40	25	65	6.5	----	----	----	----	----	----	----	----
	Dive Bomber	100	50	150	15.1	----	----	----	----	----	----	----	----
	Medium Bomber	270	180	450	45.2	----	----	----	----	----	----	----	----
	Heavy Bomber	30	20	50	5.0	----	----	----	----	----	----	----	----
	Transport & Co-op	50	30	80	8.1	----	----	----	----	----	----	----	----
	Total	620	375	995	100.0	----	----	----	----	----	----	----	----
Central	Single-eng. Pursuit	390	210	600	18.9	390	225	615	19.6	260	190	450	19.9
	Twin-eng. Pursuit	120	80	200	6.3	120	70	190	6.1	67	50	117	5.2
	Dive Bomber	300	150	450	14.2	300	180	480	15.3	118	80	198	8.7
	Medium Bomber	810	540	1350	42.6	810	525	1335	42.6	600	430	1030	45.5
	Heavy Bomber	90	60	150	4.7	90	65	155	4.9	70	50	120	5.3
	Transport & Co-op	275	145	420	13.3	275	85	360	11.5	200	160	350	15.4
	Total	1985	1185	3170	100.0	1985	1150	3135	100.0	1315	950	2265	100.0
Southern	Single-eng. Pursuit	130	70	200	15.0	130	80	210	15.4	130	95	225	18.2
	Twin-eng. Pursuit	40	25	65	4.9	40	25	65	4.8	33	25	58	4.7
	Dive Bomber	100	50	150	11.2	100	60	160	11.7	57	40	97	7.9
	Medium Bomber	270	180	450	33.7	270	180	450	33.0	250	215	465	37.6
	Heavy Bomber	30	20	50	3.7	30	20	50	3.6	30	25	55	4.5
	Transport & Co-op	275	145	420	31.5	325	105	430	31.5	200	135	335	27.1
	Total	845	490	1335	100.0	895	470	1365	100.0	700	535	1235	100.0
	GRAND TOTAL	3450	2050	5500		2880	1620	4500		2015	1485	3500	

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TABLE 10. DAILY PETROLEUM CONSUMPTION OF GERMAN PLANE MODELS

(in tons)

	American Planes			German Planes				
Type Plane	Model	Estimated Consumption per Flight	Conversion Factor	Model	Estimated Consumption per Flight	Flights per Month	Estimated Daily Consumption	
							Per Model	Average
Single-eng. Fighter	P-40	0.401	1.0	ME-109-F	0.401	20	0.268	0.306
	P-39-D	.397	1.3	FW-198	.516		.344	
Twin-engine Fighter	P-38-E	.589	0.96	ME-110	.566	20	.377	.377
Dive Bomber (light)	A-24	.527	1.2	JU-87-B	.632	15	.316	.309
	A-20-B	.814	.74	DO-215	.602		.302	
Medium Bomber	B-25	2.251	.7	JU-88 A and B	1.576	15	.788	.870
	B-26	2.971	.64		1.901		.951	
Heavy Bomber	B-17	5.066	1.08	HE-177	5.471	10	1.822	1.744
	B-24	4.675	1.07	F. W. Kurier	5.002		1.666	
Transport and Co-op	----	3.651	----	JW	3.651	15	1.826	1.826

(6096)

TABLE 11. DAILY PETROLEUM CONSUMPTION OF GERMAN PLANES

(in tons)

Front	Type of Plane	June 22-Sept. 25			Sept. 26- Nov. 1			Nov. 2-Dec.6		
			Consumption			Consumption			Consumption	
		Planes	Daily	Total	Planes	Daily	Total	Planes	Daily	Total
		Number	Tons per Plane	Tons per Day	Number	Tons per Plane	Tons per Day	Number	Tons per Plane	Tons per Day
North	Single-eng. Fighter	200	0.306	61.2	---	---	---	---	---	---
	Twin-eng. Fighter	65	.377	24.5	---	---	---	---	---	---
	Dive Bomber	150	.309	46.4	---	---	---	---	---	---
	Medium Bomber	450	.870	391.5	---	---	---	---	---	---
	Heavy Bomber	50	1.744	87.2	---	---	---	---	---	---
	Transport and Co-op	80	1.826	146.1	---	---	---	---	---	---
	Total	995	---	756.9	---	---	---	---	---	---
Central	Single-eng. Fighter	600	0.306	183.6	615	0.306	188.2	450	0.306	137.7
	Twin-eng. Fighter	200	.377	75.4	190	.377	71.6	117	.377	44.1
	Dive Bomber	450	.309	139.1	480	.309	148.3	198	.309	61.2
	Medium Bomber	1350	.870	1,174.5	1335	.870	1,161.5	1030	.870	896.1
	Heavy Bomber	150	1.744	261.6	155	1.744	270.3	120	1.744	209.3
	Transport and Co-op	420	1.826	766.9	360	1.826	657.4	350	1.826	639.1
	Total	3170	---	2,601.1	3135	---	2,497.3	2265	---	1,987.5
South	Single-eng. Fighter	200	0.306	61.2	210	0.306	64.3	225	0.306	68.9
	Twin-eng. Fighter	65	.377	24.5	65	.377	24.5	58	.377	21.9
	Dive Bomber	150	.309	46.4	165	.309	49.4	97	.309	30.0
	Medium Bomber	450	.870	391.5	450	.870	391.5	465	.870	404.6
	Heavy Bomber	50	1.744	87.2	50	1.744	87.2	55	1.744	95.9
	Transport and Co-op	420	1.826	766.9	430	1.826	785.2	335	1.826	611.7
	Total	1335	---	1,377.7	1365	---	1,402.1	1235	---	1,233.0

TABLE 12. DAILY CONSUMPTION OF PETROLEUM FOR SUPPLYING THE AIR FORCE

	June 22-July 17			July 18-Aug. 1			Aug. 2-Aug. 20			Aug. 21-Sept. 25		
	Nor.	Cent.	So.	Nor.	Cent.	So.	Nor.	Cent.	So.	Nor.	Cent.	So.
Materiel Needed Daily (in tons)	955	3,179	1,581	955	3,179	1,581	955	3,179	1,581	955	3,179	1,581
Distance to Airports (in miles)	31	63	38	19	38	31	22	31	45	15	19	25
Petroleum Needed for Hauling (in tons)	2	25	3	1	13	3	1	12	4	1	7	3

(6096)

TABLE 12. DAILY CONSUMPTION OF PETROLEUM FOR SUPPLYING THE AIR FORCE (cont.)

	Sept. 26-Oct. 20			Oct. 21-Nov. 1			Nov. 2-Nov. 17			Nov. 18-Dec. 6		
	Nor.	Cent.	So.	Nor.	Cent.	So.	Nor.	Cont	So.	Nor.	Cent.	So.
Materiel Needed Daily (in tons)	--	3,075	1,657	--	3,075	1,657	--	2,376	1,408	--	2,376	1,408
Distance to Airports (in miles)	--	31	15	--	25	31	--	19	15	--	25	25
Petroleum Needed for Hauling (in tons)	--	10	1	--	7	2	--	3	1	--	3	1

TABLE 13. CONSUMPTION OF PETROLEUM BY THE AIR FORCE

(in tons)

Front	Total June 22-Dec.6	June 22-July 17	July 18-Aug. 1	Aug. 2-Aug. 20	Aug. 21-Sept. 25	Sept. 26-Oct. 20	Oct. 21-Nov. 1	Nov. 2-Nov. 17	Nov. 18-Dec. 6
Northern	72,036	19,734	10,612	14,402	27,288	------	------	------	------
Central	410,818	68,276	36,601	49,645	93,888	62,675	30,048	31,856	37,829
Southern	226,209	35,906	19,334	26,258	49,603	35,075	16,848	19,744	23,446
All Fronts	709,063	123,916	66,547	90,305	170,784	97,750	46,896	51,600	61,275

(6096)

TABLE.14. DAILY CONSUMPTION OF PETROLEUM BY THE AIR FORCE

(in tons)

Front	June 22- July 17	July 18- Aug. 1	Aug. 2- Aug. 20	Aug. 21- Sept. 25	Sept. 26- Oct. 20	Oct. 21- Nov. 1	Nov. 2- Nov. 17	Nov. 18- Dec. 6
Northern	759	758	758	758	----	---	---	---
Central	2,626	2,614	2,613	2,608	2,507	2,504	1,991	1,991
Southern	1,381	1,381	1,382	1,378	1,403	1,404	1,234	1,234
All Fronts	4,766	4,753	4,753	4,744	3,910	3,908	3,225	3,225

(6096)

TABLE 15. PETROLEUM CONSUMPTION OF AIR AND GROUND FORCES

(in tons)

Front	Total June 22-Dec.6	June 22-July 17	July 18-Aug. 1	Aug. 2-Aug. 20	Aug. 21-Sept. 25	Sept. 26-Oct. 20	Oct. 21-Nov. 1	Nov. 2-Nov. 17	Nov. 18-Dec. 6
Northern	355,011	99,948	32,749	45,898	102,068	27,961	9,258	19,310	17,819
Central	1,190,958	362,894	123,470	113,290	136,064	190,796	63,884	70,713	129,803
Southern	843,631	154,035	64,677	121,620	264,975	90,798	38,281	45,124	64,037
All Fronts	2,389,600	616,877	220,896	280,808	503,127	309,555	111,423	135,147	211,659

(6096)

TABLE 16. DAILY PETROLEUM CONSUMPTION OF AIR AND GROUND FORCES

(in tons)

Front	June 22- July 17	July 18- Aug. 1	Aug. 2- Aug. 20	Aug. 21- Sept. 25	Sept. 26- Oct. 20	Oct. 21- Nov. 1	Nov. 2- Nov. 17	Nov. 18- Dec. 6
Northern	3,844	2,339	2,416	2,835	1,118	771	1,207	938
Central	13,958	8,819	5,963	3,780	7,632	5,326	4,420	6,832
Southern	5,924	4,620	6,401	7,361	3,632	3,191	2,820	3,370
All Fronts	23,726	15,778	14,780	13,976	12,382	9,288	8,337	11,140

(6096)